

# Lagrangian Density for the Vacuum

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## Abstract

In this paper, the Lagrangian density for the vacuum is mainly discussed, meanwhile, the matter field, the modified Lorentz transformation relations and the reasons for the invariance of the velocity of light in the vacuum are also discussed.

## 1 The problems of the existing theories<sup>[1]</sup>

We know, in special relativity, the principle of relativity and the principle of the invariance of the velocity of light in the vacuum(in this paper,  $c$  represents the velocity of light in the vacuum in special relativity) are two basic assumptions; Although some successes have been achieved, some problems still exist:

- (1) are there certain relations between the two assumptions? no answer.
- (2) what is the meaning of vacuum here? according to Einstein's meaning, the vacuum was then considered to be empty, but actually, existing theories and experiments have tell us that there is matter(for example, fields) in the vacuum, because light is a kind of matter, and there are interactions among matters, the interactions can definitely affect the velocity of light, thus we can logically obtain that the velocity of light in the vacuum is variable, and the phenomenon in which the actual velocity of light exceeds  $c$  can exist in the vacuum.
- (3) the task of physics is continuously to explore the laws of the natural world,

let people understand and make use of them better. Even if the assumption of the invariance of the velocity of light in the vacuum is correct, it is still an assumption, not explained; Why is  $c$  invariant? behind the assumption, there are definitely physical reasons, these reasons are still not found, from the theory angle, this is, of course, a problem of special relativity; if one can explain it, it is sure that a new physics will emerge.

In the unified theories, the Higgs fields play an important role, but in both the standard model and the supersymmetric theories, the Higgs field Lagrangian densities are given by hand, the reasons for how to obtain them are not explained, this is obviously a problem for the theories from the theory angle.

The unified theory has been studied for many years, and many theories have emerged: the electroweak unified theory, the standard model, the string theory, M-theory, etc. the research of these theories is still in progress, at present, the research of the primary theory has begun. Why can so many theories emerge? why do different problems still exist in different theories? in my opinion, one or more of the bases of these theories is(are) problematic, for example, the Yang-Mill's gauge theory is not complete. one of the purposes for me to write this paper is to provide a new angle(the angle of the level of disorder) for the primary theory. Besides this paper, I will discuss some problems related to the unified theory from the angle of the level of disorder in my follow-up papers. I hope that I will be able to construct an acceptable unified theory of the four basic interactions.

Now let us discuss how to solve the above-mentioned problems.

## 2 Matter Field<sup>[2]</sup>

According to the elementary particle theory, in terms of spin, all particles in the universe can be divided into two categories: one is the boson which the spin is 0, 1, 2, 3, ..., the other is the fermion which the spin is  $\frac{1}{2}, \frac{3}{2}, \frac{5}{2}, \dots$ . According to the quantum field theory, each kind of particle corresponds to one kind of field, and is the quantum excited by the field; the fermi field and the bose field can interact each other, this shows that the fermi field and the bose field have some common properties; While all matter in the universe is composed by fermions and/or bosons, thereby, the universe can be considered as one kind of field—the matter field which is more elementary than the fermi field and the bose field. Thus, any particle can be regarded as a matter field, and is a form of expression of the matter field; Any matter system can be treated as a matter field, and is a form of expression of the matter field. According to the quantum field theory, there are four kinds of elementary interactions: the strong interaction, the weak interaction, the electromagnetic interaction and the gravitational interaction. For the strong interaction and the weak interaction, the interaction range is very short, for the electromagnetic interaction and the gravitational interaction, the interaction range can be from zero to infinity. Hence, I think colour charges and weak charges are not the essential properties of the quanta of the matter field, meanwhile considered that the matter field itself is the source

of the gravitational interaction. thereby only electric charges are the essential properties of the quanta of the matter field( here, I also mean that the level of the gravitational interaction and the level of the electromagnetic interaction are the same, they are different from that of the weak interaction and the strong interaction, the former is more elementary), this means that there are only two kinds of the quanta of the matter field, they are  $M_p$  with the positive electric charge and  $M_n$  with the negative electric charge.

### 3 The modified Lorentz Transformation Relations<sup>[3]</sup>

All matter in the universe is in a certain space and time, space and time mean the space and time of matter, this implies that matter and space, time depend on and affect each other. Hence, when we investigate the physics laws of matter we must consider matter, space and time as a whole, only thus, the system considered is a complete system. Hence, when we set up a reference system, in order to meet this requirement, we must set up an abstract four dimensional reference system, and regard the time axis and the space axes as the isotopic axes, meanwhile, we stipulate that the time coordinate is imaginary(for the time axis is virtual), i. e.  $ikt$ , where  $k$  is a constant which is greater than zero,  $i$  is an imaginary symbol,  $t$  represents the real time, thus, the axes of this four dimensional reference system are  $ikt$ ,  $x$ ,  $y$ ,  $z$  respectively. Because the dimension of  $kt$  is length, the dimension of  $k$  is the velocity.

According to the principle of relativity, all inertial reference systems are equivalent. **Now that all inertial reference systems are equivalent, and the system composed by the four dimensional space and matter is complete, so in the four dimensional space, the four dimensional shape of an object must be the same in all inertial reference systems**, this means that the distance between any two points in the four dimensional space is the same in all inertial reference systems, this is the invariability of the four dimensional interval. Thereby, from the mathematical angle, the coordinate transformation between any two inertial reference systems is a rotation or the combination of a rotation and a translation in the four dimensional space, but the translation implies that the origins of the two inertial reference systems don't coincide at the beginning, no other meaning, so, only the rotation needs to be considered. The transformation for a four dimensional space rotation is a four dimensional orthogonal transformation.

Considering the two inertial reference systems  $S$ ,  $S'$ ,  $S$  moves at a velocity  $\vec{V}$  relative to  $S'$ , for an arbitrary point  $P(ikt, x, y, z)$  in  $S$ , it is corresponding to the point  $P'(ikt', x', y', z')$  in  $S'$ , thus we obtain:

$$\begin{pmatrix} ikt' \\ x' \\ y' \\ z' \end{pmatrix} = \begin{pmatrix} a_{11} & a_{12} & a_{13} & a_{14} \\ a_{21} & a_{22} & a_{23} & a_{24} \\ a_{31} & a_{32} & a_{33} & a_{34} \\ a_{41} & a_{42} & a_{43} & a_{44} \end{pmatrix} \begin{pmatrix} ikt \\ x \\ y \\ z \end{pmatrix} \quad (1)$$

where the transformation matrix  $T_{matrix}$  is an orthogonal matrix. Now considering a special case which the axes of S are parallel to the corresponding axes of S' , and the corresponding axes of S and S' have the same directions, when  $t = t' = 0$ , the origins of the two coordinate systems coincide, the direction of  $\vec{V}$  is the same as the positive direction of x axis of S , thus, the transformation matrix becomes the following form:

$$\begin{pmatrix} a_{11} & a_{12} & 0 & 0 \\ a_{21} & a_{22} & 0 & 0 \\ 0 & 0 & a_{33} & 0 \\ 0 & 0 & 0 & a_{44} \end{pmatrix}$$

In terms of the properties of the orthogonal transformation, we obtain the following equations:

$$a_{33} = a_{44} = 1 \quad (2)$$

$$a_{11}^2 + a_{12}^2 = 1 \quad (3)$$

$$a_{11}a_{21} + a_{12}a_{22} = 0 \quad (4)$$

$$a_{11}^2 + a_{21}^2 = 1 \quad (5)$$

from this, we obtain:

$$a_{11}^2 = a_{22}^2 \quad (6)$$

$$a_{12}^2 = a_{21}^2 \quad (7)$$

Considering the origin of S, in S, it means  $x = 0$  which is corresponding to  $x' = Vt'$  in S' . According to equation (1) and the transformation matrix a of the special case, we obtain the following equations:

$$ikt' = a_{11}ikt + a_{12}x$$

$$x' = a_{21}ikt + a_{22}x$$

Hence, we obtain:

$$a_{11}^2 = a_{21}^2 \frac{k^2}{V^2} \quad (8)$$

According to equations (2), (3), (4), (5), (6), (7), (8), we obtain:

$$a_{12}^2 = \frac{-V^2}{k^2 - V^2} \quad (9)$$

$$a_{11}^2 = \frac{k^2}{k^2 - V^2} \quad (10)$$

Because the positive directions of the axes of the two reference systems are the same,  $a_{11} > 0$  ,  $a_{22} > 0$ . thereby we obtain:

$$a_{11} = a_{22} = \frac{1}{\sqrt{1 - \frac{V^2}{k^2}}} , k > |\vec{V}|$$

The increment of  $t$  can result in the increment of  $x'$ , and  $a_{11}a_{21} + a_{12}a_{22} = 0$   
so,  $a_{12} = -a_{21} = \frac{\frac{iV}{k}}{\sqrt{1 - \frac{V^2}{k^2}}}$   
Thus, we obtain the transformation relations of the coordinates of the two inertial reference systems:

$$ikt' = \frac{ikt}{\sqrt{1 - \frac{V^2}{k^2}}} + \frac{\frac{ixV}{k}}{\sqrt{1 - \frac{V^2}{k^2}}} \quad (11)$$

$$x' = \frac{-iV}{k} \frac{ikt}{\sqrt{1 - \frac{V^2}{k^2}}} + \frac{x}{\sqrt{1 - \frac{V^2}{k^2}}} \quad (12)$$

$$y' = y \quad (13)$$

$$z' = z \quad (14)$$

This is the modified Lorentz transformation relations. Because  $\vec{V}$  is arbitrary, and  $k > V$ ,  $k$  is the maximum realizable velocity in the universe.

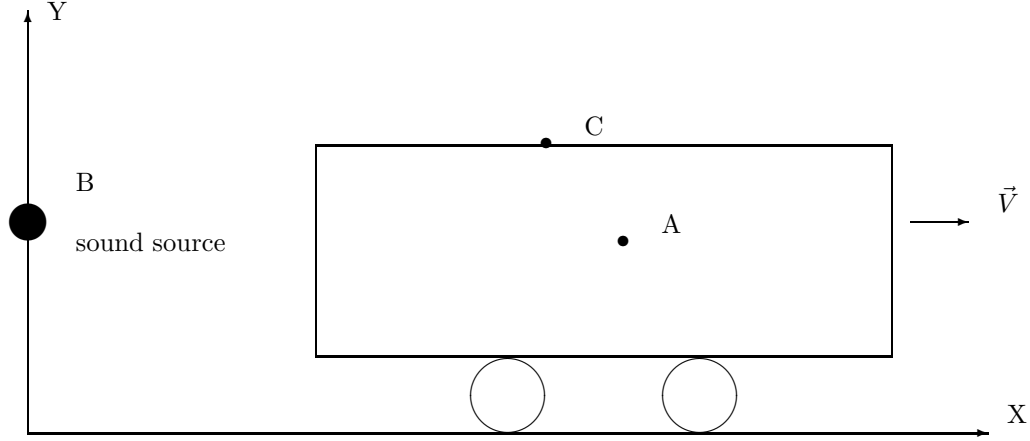
Please pay attention to the following two points:

- (1) to obtain the modified Lorentz relations, we use the principle of relativity only, do not use the principle of the invariance of the velocity of light in the vacuum; this means no certain relations between the two principles. This also implies that the principle of the invariance of the velocity of light in the vacuum is not necessary in special relativity.
- (2)  $k$  is not less than  $c$ .

## 4 The Reasons Why the Velocity of Light in the Vacuum Is Constant and Equal in All Systems Moving with Constant Velocities

In special relativity, that the velocity of light in the vacuum is constant and equal in all systems moving with constant velocities is taken as a basic assumption, till now, this assumption has still not been explained, from the theory angle, this is a problem of special relativity. Now, let us use the matter field to explain the assumption.

According to the discussions in section two, the quanta of the matter field are electrically charged, when external electric charges present, the quanta will be polarized and form a certain distribution; When the external electric charges change, the distribution will also change with the change of the external electric charges; When the external electric charges oscilate, the change of the distribution will transmit in a form of wave in space, the wave is regarded as the electromagnetic wave here. Now let us explain the reasons why the transmitting velocity of the electromagnetic wave(the polarization wave) in the vacuum is constant and equal in all systems moving with constant velocities.



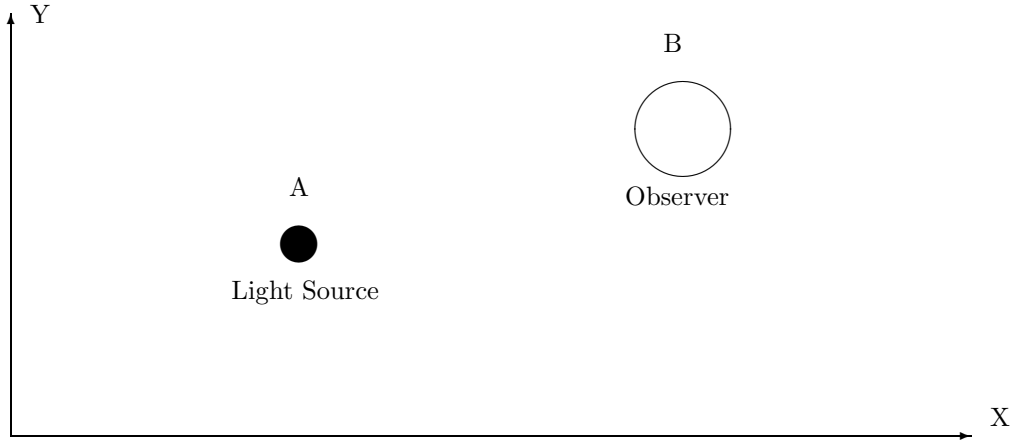
(Fig.1)

See Fig.1, there is an enough long, enough wide and enough high carriage which has an open rear side(the left side of the carriage in Fig.1) and the other closed sides and moves at a velocity  $\vec{V}$  along the positive direction of X axis, a sound source is at point B and continuously give out sound waves, the transmitting velocity of the sound waves is  $\vec{V}_s$  in air. when the sound waves arrives at observers A , C respectively, because observer C is on the top of the carriage, observer C's velocity relative to the air outside the carriage is also  $\vec{V}$ , hence, the sound velocity determined by observer C is  $\vec{V}_s - \vec{V}$ (here ignoring the effects of relativity); while observer A is in the carriage, observer A is at rest relative to the air inside the carriage, thus, when the sound waves transmit into the air inside the carriage, the velocity of the sound waves is still  $\vec{V}_s$  in the air inside the carriage. Thereby, the velocity of the sound waves determined by observer A is still  $\vec{V}_s$ , though observer A is moving with the carriage, so long as the relation of  $|\vec{V}_s| > |\vec{V}|$  is satisfied.

In terms of the same principle, we can explain the reasons why the velocity of light in the vacuum is constant and equal in all systems moving with constant velocities. Because all matter systems in the universe are matter fields, and are the forms of expression of the matter field; Meanwhile, because there are interactions between any two matter systems in the universe, there is a matter field surrounding any matter system, therefore, there is also a matter field in the vacuum. When the matter system moves, the matter field surrounding the matter system also moves with the matter system.

See Fig.2, supposed that in the vacuum there is a source of light at point A and an observer(equivalent to a matter system) at point B, observer B wants to measure the velocity of light given out by the source of light at point A. It is obvious that no matter how the relative motion between the source of light and observer B is(but must ensure that the light of the source A can transmit into the matter field surrounding observer B), because the matter field surrounding

the source of light at point A and the matter field in the vacuum mix together as well as the matter field in the vacuum and the matter field surrounding observer B also mix together, the light waves can transmit into the matter field in the vacuum from the matter field surrounding the source of light at point A, then can transmit into the matter field surrounding observer B from the matter field in the vacuum; And the velocity of light determined by observer B is always the velocity of light in the matter field surrounding observer B itself, it is impossible for observer B to directly measure the velocity of light in the vacuum, it is only possible for observer B to directly measure the velocity of light in the matter field surrounding observer B itself, so is it for the other observers, hence, the velocity of light determined by any observer is the same(supposed the matter fields surrounding all observers are the same), and is always equal to the velocity of light in the vacuum(supposed the matter fields surrounding all observers are the same as the matter field in the vacuum), so long as the absolute value of the velocity of light in the vacuum is greater than that of the velocity of any observer. Thus we have explained the reasons why the velocity of light in the vacuum is constant and equal in all systems moving with constant velocities. In 1887, in order to prove that if there was the ether in the vacuum, Michelson-Morley did the famous Michelson-Morley experiment, from the matter field's point of view, the experimental results are natural. Now let us discuss the influence on the velocity of light in the vacuum given by the density of the quanta of the matter field in the vacuum. because the density can affect the velocity of light, and the densities surrounding different observers are different, the velocities of light determined by different observers are different, normally, these differences are very small(of course, if the differences of the densities are big, the differences of the velocities are big). Set the density to which  $c$  corresponds as  $DN_c$ , because it is impossible for the vacuum to be empty, when the density is not equal to  $DN_c$ , the actual velocity of light in the vacuum is not equal to  $c$  ( $> c$  and  $< c$ ), thus we can obtain that the phenomenon in which the actual velocity of light exceeds  $c$  can exist in the vacuum.



(Fig. 2)

## 5 The Lagrangian Density for the Vacuum<sup>[4]</sup>

According to the discussions in section two and existing experimental results, we know that there are the free quanta of the matter field and the neutral and electrically charged particles which are composed by the quanta of the matter field in the vacuum, these particles are in a dynamic equilibrium state, i. e. the vacuum state. the vacuum state is also one state of the matter system. The state of a matter system is the distribution of the number density  $\rho$  (here the density for space density only) of the quanta of the matter field of the matter system in the space-time. Different state of the matter system corresponds to the different distribution. In order to investigate the change laws of the state of the matter system, we normally find a few state functions of the matter system, these state functions describe the properties of the state of the matter system from different sides, the density of the level of disorder (DOLOD for short) is such a state function of the matter system. DOLOD means the grade which the quanta of the matter field of the matter system in unit space volume are in chaotic state in the space-time, it is a scalar in the space-time. The greater DOLOD, the higher the grade, vice versa. There are two kinds of factors in a matter system, one of them makes DOLOD increase, the other makes DOLOD decrease, the natural nature of the matter system always makes DOLOD of itself increase, thereby, when the matter system is in a dynamic equilibrium state, DOLOD has and reaches a maximum

Now we discuss how to quantitatively express DOLOD. Now that the state of the matter system is the distribution of  $\rho$ , and DOLOD is a state function of the matter system, then there is definitely a direct relation between DOLOD and the distribution. Meanwhile, from the mathematical angle, if  $\rho$  were negative (for example, the number density with positive charges or negative charges), DOLOD would be still the same (compared to DOLOD with  $+\rho$  which has the same absolute value as  $-\rho$ ), so DOLOD must be the function of  $\rho^2$ . When  $\rho = 0$ , DOLOD must be zero, because  $\rho = 0$  implies that there is no matter in the space-time. When  $\rho \neq 0$  (consider number only), DOLOD must be a positive value. Thus, DOLOD caused by  $\rho$  can be expressed as the following form:

$$W_1 = W_1(\rho^2)$$

$$W_1(0) = 0 \ \& \ \frac{\partial W_1(\rho^2)}{\partial \rho^2} \big|_{0 < \rho < \rho_m} > 0, \text{ where, } \rho_m \text{ is the first extremum point of } W_1, \text{ and } \rho_m > 0$$

When  $\rho$  has a distribution in the space-time, there is a certain relation among the  $\rho$ s at all points in the matter system, the certain relation can also have contribution to DOLOD, the contribution is determined by the four dimensional gradient of  $\rho$ . Because for any point, no matter how the direction of the four dimensional gradient is, DOLOD is the same, DOLOD must be the function of the square of the four dimensional gradient; At the same time, the greater the four dimensional gradient, the smaller DOLOD, vice versa. So DOLOD caused by the four dimensional gradient can be expressed as:



$W_2 = W_2((\nabla_4\rho)^2)$ , where,  $\nabla_4$  is the symbol of the four dimensional gradient, i.e.

$$\nabla_{4u} = (\frac{\partial}{\partial(ikt)}, \nabla), u = 1, 2, 3, 4$$

$$(\nabla_4\rho)^2 = (\nabla_4\rho) \cdot (\nabla_4\rho)$$

This is the case that the matter system is at rest. When the matter system is in motion, DOLOD of the matter system will decrease, because the motion along a direction reduces the grade of chaos of the matter system. DOLOD caused by the motion of the matter system will be given from the invariability of DOLOD. DOLOD caused by the irregular motion of the quanta of the matter field can be involved in DOLOD caused by  $\rho$ , because the irregular motion can affect the distribution of  $\rho$ . For a certain matter system, under the same external conditions, the relation between the distribution of  $\rho$  and the irregular motion one-to-one. In fact, the level of this irregular motion is determined by the universe temperature. When a matter system is in a dynamic equilibrium state, the irregular motion has a certain level, the physical quantity for expressing the level is the universe temperature. the higher the universe temperature, the higher the level, vice versa; The relation between them is one-to-one; Thereby, the relation between the distribution of  $\rho$  and the universe temperature is also one-to-one. Except the above-mentioned factors, no other factor can have contribution to DOLOD. Thus, when a matter system is at rest, its DOLOD can be expressed as the following form:

$$WX = W_1(\rho^2) + W_2((\nabla_4\rho)^2)$$

Now we discuss the detailed expressions of  $W_2((\nabla_4\rho)^2)$  and  $W_1(\rho^2)$ . Expanding  $W_2((\nabla_4\rho)^2)$  into a power series:

$$W_2((\nabla_4\rho)^2) = W_{2c} + k_{22}(\nabla_4\rho)^2 + \dots$$

where,  $W_{2c}$ ,  $k_{22}$  are constants.

Because  $W_2((\nabla_4\rho)^2)$  is DOLOD for reflecting the non-uniformity of the distribution of the number density of the quanta of the matter field inside the matter system, and the non-uniformity can completely be expressed out by  $(\nabla_4\rho)^2$ , so we obtain:

$$W_2(\nabla_4\rho)^2 = W_{2c} + k_{22}(\nabla_4\rho)^2, k_{22} < 0$$

Because  $W_1(\rho^2)$  is DOLOD for reflecting the deviation of the number density of the quanta of the matter field relative to the zero point, it is related to the nature of the space-time. Expanding  $W_1(\rho^2)$  into a power series:

$$W_1(\rho^2) = W_{1c} + k_0\rho^2 + k_1\rho^4 + k_2\rho^6 + \dots$$

where,  $W_{1c}$ ,  $k_0$ ,  $k_1$ ,  $k_2$  are constants. thereby,

$$WX = W_c + k_{22}(\nabla_4\rho)^2 + k_0\rho^2 + k_1\rho^4 + k_2\rho^6 + \dots$$

where,  $W_c = W_{1c} + W_{2c}$

Now considering the case. For the vacuum, there are not only the free quanta of the matter field but also the neutral and charged particles composed by the quanta of the matter field, so, there are four kinds of number densities:

$$\rho_{s0}, \rho_{sq}, \rho_{b0}, \rho_{bq}$$

their meanings are as follows respectively:

$\rho_{s0}$ : The number density of the free quanta of the matter field at an arbitrary point;

$\rho_{sq}$ : The number density of free quanta of the net charge part of the matter field at an arbitrary point;

$\rho_{b0}$ : The number density of the particles which are composed by the quanta of the matter field at an arbitrary point(maybe have many kinds of particles, take one as a representative here);

$\rho_{bq}$ : The number density of particles of the net charge part which are composed by the quanta of the matter field at an arbitrary point(maybe have many kinds of particles, take one as a representative here).

Hence,  $W_1$  should be the function of  $\rho_{s0}^2, \rho_{sq}^2, \rho_{b0}^2, \rho_{bq}^2$ , i. e.:

$$W_1 = W_1(\rho_{s0}^2, \rho_{sq}^2, \rho_{b0}^2, \rho_{bq}^2)$$

$W_2$  should be the function of  $(\nabla_4 \rho_{s0})^2, (\nabla_4 \rho_{sq})^2, (\nabla_4 \rho_{b0})^2, (\nabla_4 \rho_{bq})^2$ , i. e.:

$$W_2 = W_2((\nabla_4 \rho_{s0})^2, (\nabla_4 \rho_{sq})^2, (\nabla_4 \rho_{b0})^2, (\nabla_4 \rho_{bq})^2)$$

thus, according to the same principle and method as the above-mentioned ones, we can obtain:

$$W_1 = W_{1cv} + \lambda_1 \rho_{s0}^2 + \lambda_2 \rho_{sq}^2 + \lambda_3 \rho_{b0}^2 + \lambda_4 \rho_{bq}^2 + \lambda_5 \rho_{s0}^4 + \cdots + \lambda_{14} \rho_{bq}^4 + \cdots$$

where,  $W_{1cv}, \lambda_1, \lambda_2, \cdots, \lambda_{14}$  are constants.

$$W_2 = W_{2cv} + h_1 (\nabla_4 \rho_{s0})^2 + h_2 (\nabla_4 \rho_{sq})^2 + h_3 (\nabla_4 \rho_{b0})^2 + h_4 (\nabla_4 \rho_{bq})^2$$

where,  $W_{2cv}, h_1, h_2, h_3, h_4$  are constants.

thereby,

$$WX = W_{cv} + W_{1y} + W_{2y} \quad (15)$$

where,  $W_{cv} = W_{1cv} + W_{2cv}$

$$W_{1y} = \lambda_1 \rho_{s0}^2 + \lambda_2 \rho_{sq}^2 + \lambda_3 \rho_{b0}^2 + \lambda_4 \rho_{bq}^2 + \lambda_5 \rho_{s0}^4 + \cdots + \lambda_{14} \rho_{bq}^4 + \cdots$$

$$W_{2y} = h_1 (\nabla_4 \rho_{s0})^2 + h_2 (\nabla_4 \rho_{sq})^2 + h_3 (\nabla_4 \rho_{b0})^2 + h_4 (\nabla_4 \rho_{bq})^2$$

Because  $\rho_{s0}, \rho_{sq}, \rho_{b0}, \rho_{bq}$  are the different ingredients of the vacuum, for the vacuum, they are isotopic. Thus, they can be regarded as different components of a isovector in the isospace, i. e. :

$$\rho_v = \begin{pmatrix} f_{s0} \rho_{s0} \\ f_{sq} \rho_{sq} \\ f_{b0} \rho_{b0} \\ f_{bq} \rho_{bq} \end{pmatrix}$$

where,  $f_{s0}, f_{sq}, f_{b0}, f_{bq}$  are constants. But in the space-time,  $\rho_v$  is a scalar. Thus, Thus, we naturally hope that we can express DOLOD for the vacuum as the following form:

$$WX_v = W_{zcv} + \beta_0 |\nabla_4 \rho_v|^2 + \beta_1 |\rho_v|^2 + \beta_2 |\rho_v|^4 + \beta_3 |\rho_v|^6 + \cdots \quad (16)$$

where,  $W_{zcv}, \beta_0, \beta_1, \beta_2, \beta_3$  are constants,

$$|\nabla_4 \rho_v|^2 = (\nabla_4 \rho_v)^\dagger (\nabla_4 \rho_v),$$

$$|\rho_v|^2 = \rho_v^\dagger \rho_v$$

From the mathematical angle, if we expand  $WX_v$  into the form of the right side of equation (15), the total items of the right side of equation (16) are equal

to that of equation (15), hence, so long as the coefficients of the corresponding items of the two equations are equal, equation (16) can be realized, while this is completely possible. Here, equation (8) is selected to be the form of expression of DOLOD for the vacuum, because equation (16) can express the entirety and harmonicity of the vacuum better.

According to the theory of the solid state physics, the third order derivative and the above of the potential of atoms are non-harmonic items, they are the reasons for the expansion caused by heat and contraction caused by cold, if no these derivatives, then no phenomenon of expansion caused by heat and contraction caused by cold. Here,  $W_1$  is equivalent to the potential,  $\rho^2$  is equivalent to the distance between two atoms. Under a certain universe temperature, the quanta of the matter field in the universe are in a certain dynamic equilibrium state and have a certain average of the number density at any point. When the universe temperature changes, the instantaneous number density of the quanta of the matter field will change, if the average of the number density is different from that of before the change of the universe temperature, then the third order derivative and the above of  $W_1$  are not zero; vice versa. Of course, the change of the universe temperature must be within a certain range, out of this range, the average of the number density for the dynamic equilibrium state will change. In actual situations, what we investigate is a part of the universe, not the whole universe, so we can encounter non-harmonic problems, if what we investigate is the whole universe, or even if a part of the universe, but we consider all of the relevant factors, we will also not encounter non-harmonic problems. Maybe this is one of the meanings that the universe is harmonic. The harmonic point of view will be stuck to in this paper. Thus, DOLOD for the vacuum can be expressed as the following form:

$$WX_v = W_{zcv} + \beta_0 |\nabla_4 \rho_v|^2 + \beta_1 |\rho_v|^2 + \beta_2 |\rho_v|^4 \quad (17)$$

Now we discuss the constants of equation (17). For equation (17), in the space-time,  $\rho_v$  is a scalar, so, according to the preceding discussion in this section,  $\beta_0 < 0$ ; when the vacuum matter system is in dynamic equilibrium state, its DOLOD has and reaches a maximum, so  $\beta_1 > 0$ ,  $\beta_2 < 0$ . For the constants in  $\rho_v$ , consider the expanding form of equation (17) which is the same as the right form of equation (15), the following conditions must be satisfied:

$$f_{s0} > 0, f_{b0} > 0$$

Since the greater the square of the four dimensional gradient of the number density of the net charge part, the greater DOLOD, vice versa; the greater the square of the number density of the net charge part, the smaller DOLOD, vice versa, we can also obtain the following relations:

$$f_{sq}^\dagger f_{sq} < 0, f_{bq}^\dagger f_{bq} < 0$$

so  $f_{sq}$ ,  $f_{bq}$  must be operators and commute with  $\nabla_4$ . doing the replacement:

$$f_{sq} \rightarrow f_{sq} \hat{C}_N, f_{bq} \rightarrow f_{bq} \hat{C}_N, f_{sq} > 0, f_{bq} > 0$$

where,  $\hat{C}_N$  is an operator and commutes with  $\nabla_4$ , and satisfies the condition:

$\hat{C}_N^\dagger \hat{C}_N = -\hat{I}$ , where,  $\hat{I}$  is the identity operator.

This operator is a conversion operator between the number density of a net charge part and the same neutral number density, called the charge conversion operator. According to the meaning of the charge conversion operator, it must also satisfy the following condition:

$$\hat{C}_N \hat{C}_N = \hat{I}, \hat{C}_N^{-1} = \hat{C}_N$$

Thus we obtain:

$$\rho_v = \begin{pmatrix} f_{s0}\rho_{s0} \\ f_{sq} \hat{C}_N \rho_{sq} \\ f_{b0}\rho_{b0} \\ f_{bq} \hat{C}_N \rho_{bq} \end{pmatrix}$$

In terms of the discussions of section three, we can obtain that the length of a moving object will contract. Supposing the rest length of the object is  $L$ , when the object moves at a velocity  $\vec{V}$  along the direction in which the length of the object is measured, the length of the object in the direction of  $\vec{V}$  becomes:  $L\sqrt{1 - \frac{V^2}{k^2}}$ , so for the vacuum, the effect of length contraction will lead to that the four kinds of number densities in  $\rho_v$  will increase to  $\frac{1}{\sqrt{1 - \frac{V^2}{k^2}}}$  as much as that of at rest. Because all inertial systems are equivalent, and DOLOD is an invariable, we must modify the expression of DOLOD to meet the requirement. According to equation (17), if  $\rho_v$  is a rest physical quantity  $\rho_{vr}$ ,  $WX_v$  is an invariable. Thus, when the matter system moves at a velocity  $\vec{V}$ , the invariable expression of DOLOD is as follows:

$$WX_v = W_{zcv} + \beta_0(1 - \frac{V^2}{k^2})|\nabla_4\rho_v|^2 + \beta_1(1 - \frac{V^2}{k^2})|\rho_v|^2 + \beta_2(1 - \frac{V^2}{k^2})^2|\rho_v|^4 \quad (18)$$

According to the meanings of Lagrangian density and DOLOD, from the angle of the physics essence, Lagrangian density and DOLOD are equivalent, so the Lagrangian density for the vacuum is:

$$L_v = W_{zcv} + \beta_0(1 - \frac{V^2}{k^2})|\nabla_4\rho_v|^2 + \beta_1(1 - \frac{V^2}{k^2})|\rho_v|^2 + \beta_2(1 - \frac{V^2}{k^2})^2|\rho_v|^4 \quad (19)$$

Please pay attention to that this expression is correct for the vacuum only. If the matter system is at rest, the Lagrangian density becomes:

$$L_v = W_{zcv} + \beta_0|\nabla_4\rho_{vr}|^2 + \beta_1|\rho_{vr}|^2 + \beta_2|\rho_{vr}|^4$$

According to the meaning of Higgs field, this is the Lagrangian density for Higgs field. Thus we obtain the Lagrangian density for Higgs field. let  $k = c$ , then obtain:

$$-|\nabla_4\rho_{vr}|^2 = (\partial_u\rho_{vr})^\dagger\partial^u\rho_{vr}, u = 1, 2, 3, 4$$

where,  $\partial_u$ ,  $\partial^u$  are the covariant form derivative and the contravariant form derivative, thus we obtain:

$$L_v = W_{zcv} - \beta_0(\partial_u \rho_{vr})^+ \partial^u \rho_{vr} + \beta_1 |\rho_{vr}|^2 + \beta_2 |\rho_{vr}|^4 \quad (20)$$

this is the form of the Lagrangian density of Higgs field which is used in the electroweak unified theory(the difference between them is a constant only). Though their forms are similar, the component numbers in the isospace are different(In the electroweak unified theory, how to obtain the Lagrangian density of Higgs field has not been explained, so is it in supersymmetric theories). In my follow-up papers, I will discuss the essence of time, the origin of mass, the origin of spin, the quantization of electric charge; the four basic interactions and their unification from the angle of the level of disorder.

## 6 References

[1]: Nir Polonsky, Supersymmetry:Structure and Phenomena, Extensions of Standard Model, Springer(2001).

Gordon Kane, Supersymmetry, Squarks, Photinos and Unveiling of the Ultimate Laws of Nature. Perseus Publishing, Cambridge Massachusetts(2000)

[2]: Amitabha Lahiri, Palash B. Pal, Quantum Field Theory, CRC Press (2000)

[3]: Edited and translated by Fan Dai Nian, Zhao Zhong Li, Xu Liang Ying.The Collected Papers of Einstein, Vol. 2. Published by the Commercial Press (1983).

[4]: Original Author, Huang Kun, Revised by Han Qi, Solid StatePhysics, Senior Education Press (1985).

W.Greiner B.Müller J.Rafelski, Quantum Electrodynamics of Strong Fields, Springer-Verlag,Berlin Heidelberg New York okyo(1985).